

What is claimed:

1. A positioning system, comprising:
 - a plurality of devices, each device including:
 - a transceiver for exchanging RF signals with the other of the plurality of devices; the transceiver periodically receiving a message from each other device of the plurality of devices during time slots assigned to the other devices;
 - local clock for generating a local clock signal;
 - receiver logic for determining a time of arrival, relatively to the local clock signal, of the message from each of the other devices;
 - transmitter logic for periodically transmitting messages to the other devices during a time slot assigned to said device, each transmitted message including information representing the determined time of arrival for at least one of the other devices;
 - wherein the received message from each other device includes information representing a time of arrival at the other device of a respective message transmitted by said device;
 - at least one of the devices further including ranging logic for determining a respective range to each of a plurality of the other devices, said determined respective range to a respective device of the other devices being determined as function of the determined time of arrival of the message from the other device and the time of arrival information in the message from the other device.
2. The positioning system of claim 1, wherein the ranging logic is configured to determine an average time of flight of the messages sent by and received at said device with respect to a respective device of the other devices.
3. The positioning system of claim 1, wherein the ranging logic is configured to determine an average time of flight, comprising an average of a first time of flight of the message sent by a respective device of the other devices to said device and second time of flight of the message sent by said device to said respective device, and to determine a distance between said device and said respective device based on said average time of flight.

4. The positioning system of claim 1, wherein at least two devices of the plurality of devices each includes clock synchronization logic for synchronizing the local clock with a local clock in a particular device of the plurality of devices.
5. The positioning system of claim 4, wherein
the local clock includes a counter updated at a rate controlled by a local oscillator, the counter generating a local time value; and
the clock synchronization logic includes clock steering logic that includes a register storing an adjustment value, and an analog clock signal generator responsive to the adjustment value in the register for generating a steered clock signal that is approximately synchronized with the local clock the other one of the plurality of devices.
6. The positioning system of claim 5, wherein the receiver logic is configured to utilize the steered clock signal to determine a difference between an edge in the steered clock signal and an edge in the message from the other one of the plurality of devices.
7. The positioning system of claim 6, wherein the clock steering logic includes logic for updating the adjustment value stored in the register in accordance with the difference between an edge in the steered clock signal and the edge in the message from the other one of the plurality of devices.
8. The positioning system of claim 6, wherein the receiver logic includes at least one windowing filter for integrating a received signal during a window time frame determined relative to the steered clock signal.
9. The positioning system of claim 8, wherein the window time frame used by the windowing filter is a sequence of window time frames, of different durations, used during a sequence of time periods to integrate the received signal.

10. The positioning system of claim 9, wherein a last window time frame of the sequence of window time frames is at least 100 times smaller than a first window time frame of the sequence of window time frames.
11. The positioning system of claim 5, wherein the adjustment value used by the analog clock signal generator specifies a relative phase of the steered clock signal with a precision better than one thousandth of a clock cycle.
12. The positioning system of claim 5, wherein the clock synchronization logic includes a summer for summing the local time value and the adjustment value to generate a time value approximately synchronized with the local clock in another one of the plurality of devices.
13. A device for use in a positioning system, the device comprising:
- a receiver for receiving a message signals from another device in the positioning system;
 - a local clock for generating a local clock signal, the local clock including a local oscillator;
 - receiver logic for determining a time of arrival, relatively to the local clock signal, of the message from the other device;
 - ranging logic for determining a respective range to the other device as a function of the determined time of arrival; and
 - clock synchronization logic, including clock steering logic that includes a register storing an adjustment value, and an analog clock signal generator responsive to the local oscillator and the adjustment value in the register for generating a steered clock signal that is approximately synchronized with a local clock in the other device.
14. The device of claim 13, wherein the receiver logic is configured to utilize the steered clock signal to determine a difference between an edge in the steered clock signal and an edge in the message from the other device.

15. The device of claim 14, wherein the clock steering logic includes logic for updating the adjustment value stored in the register in accordance with the difference between an edge in the steered clock signal and the edge in the message from the other one of the plurality of devices.
16. The device of claim 14, wherein the receiver logic includes at least one windowing filter for integrating a received signal during a window time frame determined relative to the steered clock signal.
17. The device of claim 16, wherein the window time frame used by the windowing filter is a sequence of window time frames, of different durations, used during a sequence of time periods to integrate the received signal.
18. The device of claim 17, wherein a last window time frame of the sequence of window time frames is at least 100 times smaller than a first window time frame of the sequence of window time frames.
19. The device of claim 13, wherein the adjustment value used by the analog clock signal generator specifies a relative phase of the steered clock signal with a precision better than one thousandth of a clock cycle.
20. The device of claim 13, wherein the local clock includes a counter updated at a rate controlled by a local oscillator, the counter generating a local time value.
21. The device of claim 20, wherein the clock synchronization logic includes a summer for summing the local time value and the adjustment value to generate a time value approximately synchronized with the local clock in another one of the plurality of devices.
22. A method of operating a positioning system having a plurality of devices, each device configured to exchange RF signals with the other of the plurality of devices, comprising the steps of:

periodically receiving, at a first device, a message from each other device of the plurality of devices during time slots assigned to the other devices, the received message from each other device including information representing a time of arrival at the other device of a respective message transmitted by the first device;

determining a time of arrival, relatively to a local clock signal of a local clock of the first device, of the message from each of the other devices;

periodically transmitting messages to the other devices during a time slot assigned to the first device, each transmitted message including information representing the determined time of arrival for at least one of the other devices; and

determining a respective range from the first device to each of a plurality of the other devices, said determined respective range to a respective device of the other devices being determined as function of the determined time of arrival of the message from the other device and the time of arrival information in the message from the other device.

23. The method of claim 22, wherein determining a respective range includes determining an average time of flight of the messages sent by and received at the first device with respect to a respective device of the plurality of other devices.

24. The method of claim 22, wherein determining a respective range includes determining an average time of flight, comprising an average of a first time of flight of the message sent by a respective device of the other devices to the first device and second time of flight of the message sent by the first device to the respective device, and determining a distance between the first device and the respective device based on the average time of flight.

25. The method of claim 22, further including synchronizing the local clock of at least two of the plurality of devices with a local clock in a particular device of the plurality of devices.

26. The method of claim 25, wherein the receiving step further includes:

updating a counter belonging to the local clock at a rate controlled by a local oscillator, the counter generating a local time value;

storing an adjustment value in a register; and
generating, based on the adjustment value, a steered clock signal that is approximately synchronized with the local clock the other one of the plurality of devices.

27. The method of claim 26, wherein the receiving step further includes:

utilizing the steered clock signal to determine a difference between an edge in the steered clock signal and an edge in the message from the other one of the plurality of devices.

28. The method of claim 27, wherein the receiving step further includes:

updating the adjustment value stored in the register in accordance with the difference between an edge in the steered clock signal and the edge in the message from the other one of the plurality of devices.

29. The method of claim 28, wherein the receiving step further includes:

integrating a received signal during a window time frame determined relative to the steered clock signal.

30. The method of claim 29, wherein the received signal is integrated multiple times during a sequence of time periods, the integrating occurring during a sequence of window time frames of different durations.

31. The method of claim 30, wherein a last window time frame of the sequence of window time frames is at least 100 times smaller than a first window time frame of the sequence of window time frames.

32. The method of claim 26, wherein the adjustment value specifies a relative phase of the steered clock signal with a precision better than one thousandth of a clock cycle.

33. The method of claim 26, further including:

summing the local time value and the adjustment value to generate a time value approximately synchronized with the local clock in another one of the plurality of devices.

34. A method for operating a device in a positioning system, comprising:
- receiving a message signal from another device in the positioning system;
 - generating a local clock signal;
 - determining a time of arrival, relatively to the local clock signal, of the message from the other device;
 - determining a respective range to the other device as a function of the determined time of arrival;
 - storing an adjustment value in a register; and
 - generating, based on the adjustment value, a steered clock signal that is approximately synchronized with the local clock the other device.
35. The method of claim 34, further including determining a difference between an edge in the steered clock signal and an edge in the message from the other device.
36. The method of claim 35, further including updating the adjustment value stored in the register in accordance with the difference between an edge in the steered clock signal and the edge in the message from the other device.
37. The method of claim 36, wherein the receiving step further includes:
- integrating a received signal during a window time frame determined relative to the steered clock signal.
38. The method of claim 37, wherein the received signal is integrated multiple times during a sequence of time periods, the integrating occurring during a sequence of window time frames of different durations.

39. The method of claim 38, wherein a last window time frame of the sequence of window time frames is at least 100 times smaller than a first window time frame of the sequence of window time frames.

40. The method of claim 34, wherein the adjustment value specifies a relative phase of the steered clock signal with a precision better than one thousandth of a clock cycle.

41. The method of claim 34, further including:

summing the local time value and the adjustment value to generate a time value approximately synchronized with the local clock in another one of the plurality of devices.